NATO/CCMS Pilot Study on
Clean Products and Processes – Phase I

EXECUTIVE SUMMARY

Clean Products and Processes (CPP) – Phase I was an attempt to lay the foundation of an effective pilot study in which the state of the art information on cleaner manufacturing processes, and tools for designing and assessing them were exchanged. The Pilot started with 14 countries and at the concluding meeting at Vilnius, Lithuania stood at 27 member nations participating. CPP-Phase I was a success as evidenced by widespread interest in a Phase II (already approved) by the members of Phase I and the willingness of several other European countries to join. CPP-Phase I was the first step towards a scientific and technological approach to sustainable development from the perspective of manufacturing sectors. For the explicit purpose of exploring the product and process options that offer minimizing environmental impacts at the lowest possible cost, throughout the last five years we have examined scientific tools and methods that can be universally used to assess design and assessment tools and methods for processes and products. The inaugural meeting of Phase I was hosted by the US Environmental Protection Agency in Cincinnati, Ohio in 1998, and the subsequent annual meetings were held in Belfast, Northern Ireland (UK), Copenhagen (Denmark), Oviedo (Spain), and Vilnius (Lithuania), with support from the host institutions and countries. Working collectively we selected the dominant industries in need of cleaner approaches and discussed how the state of the art knowledge can make a difference. We also explored the specific problems afflicting each member nation, and invited experts to educate us all on selected industry sectors (such as textile) and specific approaches (such as industrial ecology). The measure of success of CPP-Phase I was thought to be the effective dissemination of research products for use by participating countries, and the creation of productive collaboration projects among experts from participating countries. Many such beneficial products and collaborations were achieved, only some of which are mentioned below:

- Several of the pollution prevention and assessment tools developed by the US EPA are made available through the EPA website, accessible through the NATO CCMS website. These tools are widely used among the Pilot member countries. Some of the more recently developed tools are in demand and will be made available soon.
- Phase I has completed one assessment of pollution prevention practices (and barriers to it) in member countries in textiles, and the report is available in the EPA website. Data for two other assessments on metal finishing and food/agricultural sectors have been collected from the CPP members and the reports are in preparation.
- Denmark has a successful collaboration with Solutia (USA) on industrial water use reduction and water recycling. The results have facilitated another collaboration between Denmark and Lithuania, and a third between Denmark and Turkey.
- UK (Queen's University, Belfast) and USA (University of Arizona) have launched a collaboration in biofilm characterization and reduction for ultrapure water used in electronic industry.
- The concept of the establishment of NSF's Industry-University Cooperative research Center was discussed in the Pilot. Prof. Jim Swindall of the QUESTOR Center (Belfast) made a separate invited presentation in Israel. The establishment of these centers is being explored in several countries with help from this Pilot.
- Mrs. Teresa Mata (Portugal) acquired a Fullbright fellowship to work with US EPA in Cincinnati on cleaner design techniques as part fulfillment of her Ph.D. in chemical engineering from University of Porto.
- Several multi-country collaborative projects have just been formed involving such countries as Czech Republic, Israel, Turkey, Poland, Hungary, Denmark, Spain, Russia, Italy, Germany, Norway, Greece, Lithuania, and the USA. The industry sectors that have

been targeted for cleaner practices are hospitals, industrial park management, use of membranes in milk, olive oil and chemicals, agricultural ecology, and sustainability indicators for benchmarking.

Introduction

The concept of sustainable development universally accepted as the means of protecting the environment for all mankind, demands that future manufacturing technologies must be cleaner, yet economically sound. The goal of sustainable development will, in the manufacturing sectors, be achieved by a combination of several methods. One method is improved housekeeping in process plants leading to large reductions of emissions and discharges of pollutants. Another method is significant modifications of existing process technologies through the application of sound science and advanced technologies. Yet another method is totally new process designs that are environmentally preferable, made possible by using tools for life cycle assessment (LCA) and environmental impacts. An effective pilot study will have far-reaching influence on future developments in NATO and the partnership countries, in fact throughout the world. Such a pilot study needs to put together, for the benefit of all nations, exemplary developments in three important areas. First, we must address the issue of measuring cleanliness through devising environmental or sustainability indicators (called analytical tools or computer software). Second, we must examine cleaner techniques for achieving specific goals in selected industry sectors, such as power generation, textile, pulp and paper, leather tanning, metal finishing, and mining. Third, we must examine advanced techniques for cleaner product designs. Additionally an effective web-based dissemination method needs to be established to share the knowledge among academia, Government agencies, and industries of all nations.

CPP-Phase I was an attempt to lay the foundation of such an effective pilot study. This pilot first met in Cincinnati in 1998 with 14 members in attendance. The second, third, and the fourth annual meetings were held in Belfast, Northern Ireland, UK, Copenhagen, Denmark, and in Oviedo, Spain, respectively, while the membership increased to 27 currently. The fifth and concluding meeting of Phase I took place in May, 2002, in Vilnius, Lithuania.

Our initial goal of creating an effective forum for exchanging new ideas, knowledge, and methods for achieving cleaner products and processes has been achieved. The Phase I was launched at a time when the environmental impacts of industry and its products, and the depletion of natural resources were just beginning to be appreciated. Additionally, in the span of the last five years, only a few technology sectors could be examined. The need for keeping this forum alive for free exchange of ideas for continued sharing among the member nations, Phase II is needed to conduct the unfinished business of dealing with the exploding developments in cleaner technologies and methods and to address some of the more important industry sectors.

Phase I Activities

Activities conducted as part of CPP-Phase I centered around five annual meetings and follow-up communications, information sharing, and collaborations among the participating countries.

Annual Meetings

Each annual meeting followed the same basic format which included formal plenary sessions; updates on the progress of cleaner products and processes in each country; overviews of special projects; presentations from special guest experts; field visits to universities where clean product and process research is being conducted and to industrial sites where clean production and processing is being applied; special topic seminars; and an open forum on cleaner production and processing.

Cincinnati, Ohio, USA - 1998

The first annual meeting of CPP-Phase I was held in Cincinnati, Ohio, USA, in March of 1998, and was hosted by the U.S. Environmental Protection Agency. As the "kickoff" meeting for CPP-Phase I, a major focus of the meeting was to formulate a direction for the 5-year pilot study. In addition to "tour de table" presentations from each of the 14 attending countries, special guest presentations included:

- European Cleaner Technology Research
- U.S. DOE - Industries of the Future: Creating a Sustainable Technology Edge
- Environmentally Benign Semiconductor Manufacturing
- Cleaner Technology and Production Islands in Economies in Transition
- Software Tools for Cleaner Production
- Environmental Design of Industrial Products
- Economical Cryogenic Machining

Meeting participants visited several location to observe ongoing technology demonstrations and research activities being conducted in the Cincinnati area. Tours of the Institute of Advanced Manufacturing Sciences and the University of Cincinnati's College of Engineering were conducted to familiarize attendees with several projects related to clean manufacturing and clean products. In addition, meeting participants were given the opportunity to enjoy Cincinnati's Museum of Fine Arts which displays a wide range of art from ancient times to the modern era.

Belfast, Northern Ireland, UK - 1999

The second annual meeting was held in Belfast, Northern Ireland, United Kingdom, in March of 1999 and was hosted by Queen's University in Belfast. The meeting drew participants from 18 countries. The meeting followed the format established by the Cincinnati meeting. The scope of the special topic presentation was expanded and included clean product and process experts from several countries. Technical topics included:

- Process Integration Technology for Clean Processes
- Ionic Liquids: Neoteric Solvent Research and Industrial Applications
- Industrial Energy Efficiency: Focus on Metal Casting
- Use of Supercritical Carbon Dioxide in Clean Production
- Liquid Effluent Treatment Research and Development at British Nuclear Fuels
- Help for Sustainable Waste Management through Waste Reduction and Clean Technology

Meeting participants visited locations in Northern Ireland to observe ongoing technology applications and practices and research activities. A tour of the Queen's University Environmental Science and Technology Research Center (QUESTOR) provided an opportunity to view research facilities and projects being conducted as part of QUESTOR's unique industry-university partnership program. In addition, attendees visited the Old Bushmills Distillery and the DuPont Maydown Plant to familiarize themselves with clean production activities being applied in the area. Meeting participants also toured the scenic Antrim Coast and visited the Giant's Causeway, a World Heritage Site, to view this impressive and awe-inspiring geologic formation.

Copenhagen, Denmark - 2000

The third meeting of CPP-Phase I was held in Copenhagen, Denmark, in May of 2000 and was hosted by the Technical University of Denmark. This meeting initiated the inclusion of a special topic seminar and computer tool café in the CPP-Phase I annual meetings. The traditional

special invited presentations continued with the following topics being addressed:

- Engineering for Sustainable Development - An Obligatory Skill of the Future Engineer
- Membranes in Process Intensification and Cleaner Production
- Approaches to Cleaner Production in Economies in Transition - Results and Perspectives of the Cleaner Production Centers
- Computer Aided Molecular Design Problem Formulation and Solution: Solvent Selection and Substitution
- The First Step Towards Sustainable Business Practices: The "Design for the Environment" Tool Kit
- Biological Control fo Microbial Growth in the Process Water of Molded Paper Pulp Production - Avoiding the Use of Biocides

As mentioned above, two new "features" were added to the CCP-Phase I annual meeting format at the meeting in Copenhagen. First, in order to provide an opportunity for meeting participants to demonstrate and use computer-based software tools, a "Computer Tools Café" was set-up. Several participants were able to provide "hands-on" demonstrations of the tools being developed in their countries. Demonstrated at this meeting were a chemical life cycle database, tools for chemical and process system engineering, a life cycle assessment tool for the environmental design of industrial products, and a tool for identifying environmentally friendly chemical substitutions for industrial processes.

Second, a special topic seminar titled, "Product Oriented Environmental Measures" was presented. The seminar included eleven presentations which highlighted innovative product design applications and programs, with special emphasis on product design being conducted in the Scandinavian countries. The seminar presented product design initiatives at the government level and actual product design programs and applications at several companies.

Meeting participants visited the Technical University of Denmark (DTU) to become familiar with DTU's research facilities and ongoing research projects relating to clean products and processes. Participants also visited Kalundborg where industrial symbiosis is practiced among the Asnaes Power Station, Gyproc (plasterboard manufacturer), Novo Nordic (pharmaceutical and biotechnology), Statoil Refinery, and the Municipality of Kalundborg. Meeting participants also visited the Viking Museum in Roskilde and a haunted old Danish castle.

Oviedo, Spain - 2001

The fourth annual meeting of CPP-Phase I was held in Oviedo, Spain, in May of 2001, and was hosted by the University of Oviedo. The meeting included participants from 21 countries. As in the previous meetings, updates on clean production activities in each country were presented, along with briefings on pilot projects being conducted by participating countries. In addition, several specially invited experts presented information on relevant topics.

The precedent set in Copenhagen was continued with the presentation of a special topic seminar, "Environmental Challenges in the Processes Industries". Many speakers from throughout Spain addressed several important policy and technical issues, including:

- Advances in the Environmental Aspects of Desalination: The Canary Island Experience
- Lignosulphonates: Environmental Friendly Products from a Waste Stream
- Hydrogen Economy and Fuel Cells
- The Use of Membrane Technology in the Pulp and Paper Industry
- Treatment of Oil-Containing Wastewaters Using Clean Technologies

- Non-Ferrous Metallurgical Wastes: Future Requirements
- Making Carbochemistry Compatible with the Environment
- Treatment of Phenolic Wastewaters in the Salicylic Acid Manufacturing Process
- Principality of Asturias Environmental Policy
- Supporting Companies and Businesses to Improve Their Relationship with the Environment in Catalonia
- New Legislation on Environmental Quality and Clean Production in Spain

Meeting participants visited the Department of Chemical Engineering at the University of Oviedo and toured several laboratories and the department's pilot plant facility. The field trip continued with a visit to the DuPont Company's Asturias plant. At the plant, the participants were able to tour the NOMEX production facility. In addition, the tour include a very interesting visit to the site's ecosystem restoration projects. Finally, the participants visited a cider production plant in Villaviciosa.

Vilnius, Lithuania - 2002

The fifth and final meeting of CPP-Phase I was held in Vilnius, Lithuania, in May of 2002 and was hosted by the Institute of Environmental Engineering at Kaunas University of Technology. This meeting was highlighted with a special visit to Lithuania's Presidential Palace and a meeting with President Valdas Adamkus. The topic for this meeting's special seminar was industrial ecology which included presentations addressing:

- Industrial Ecology and Eco-Efficiency
- From Pollution to Industrial Ecology and Sustainable Development
- Green Concurrent Engineering: Filling ISO 14001 with Content
- Strategies and Mechanisms to Promote Cleaner Production Financing
- Cleaner Production Financing: Possibilities and Barriers
- Industrial Ecology in University Curricula
- Chemicals Risk Management in Enterprises
- Practical Implications of Industrial Ecology in Lithuania
- International Implications of Industrial Ecology

The traditional field trip included visits to three Lithuanian industrial sites to view cleaner production and processes. First, the participants toured the refrigerator production company, Snaige. The next tour was conducted at the textile company, Alytaus Tekstile. The final tour of the field trip was of the wine and sparkling wine production company, Alita.

The discussion during the closing session of the meeting focused on the transition from CPP-Phase I to CPP-Phase II.. A review of the Phase II proposal that has been approved by NATO CCMS was presented by the Pilot Study Co-Director. The proposal reaffirmed the goals of Phase I and established the following goals for Phase II:

- To support the development of eco-efficiency and sustainability indicators and promote consistency and harmonization of their application;

- To examine and exchange information on state-of-the-art advancements in product design and process development in service and industrial sectors of importance to participating nations;

- To develop a web-based portal for the dissemination of pilot study results and improved awareness of related global developments; and

- To stimulate and facilitate productive collaboration among all participating

nations.

The first annual meeting of CPP-Phase II will be held in Calabria, Italy in May 2003 and will be hosted by the University of Calabria. A special focus of the meeting will be on clean production and processes in the food production and agriculture industry.

In addition to annual meetings, pilot projects were selected and implemented by delegates from participating countries. Pilot projects are intended to foster international collaboration on special clean product and processes endeavors which usually apply a tool, methodology, or technology. These pilot projects are usually multi-year efforts with annual progress reports presented at the annual meeting. In CPP-Phase I, the following pilot projects were implemented:

- Product Oriented Environmental Measures in the Textile Industry - Denmark
- Pollution Prevention Tools - United States
- Energy Efficiency - Moldova
- Water Conservation and Recycling in the Semiconductor Industry - United Kingdom and United States
- Research and Development Aimed at Developing Cleaner Production Technologies to Assist the Textile Industry - Turkey
- Pollution Prevention Development and Utilization - United States
- Cleaner Energy Production with Combined Systems - Turkey
- Environmental Impact of Hydrocarbon Emissions in Life Cycle Analysis of Gasoline Blending Options - Portugal
- Pilot Study Web Site - United States
- Cleaner Production Approaches in Industrial Parks/Industrial Symbiosis/Industrial Ecology - Denmark, Hungary, Israel, Poland, and Turkey
- Hybrid Membrane Applications for Cleaner Production - Denmark, Italy, Poland, Russia, and Spain
- Sustainable Indicators/Bench Marking - Germany, Hungary, Lithuania, and Norway

Summary

As indicated by the participation of 27 countries in CPP-Phase I and the high level of interaction and information sharing, CPP-Phase I has been an overwhelming success. This pilot study has initiated several collaborative projects that have been mutually beneficial to those countries that have participated. In addition, through comprehensive information sharing, this pilot study has provided participating countries and others with access to valuable technical information to assist in the implementation of clean product design, clean production, and clean processes in industries around the world.

The CPP-Phase I web site, located at:

provides participating countries and others with a portal to clean product and processes information and updates on activities conducted and planned for this pilot study. Each annual report is available on-line and information on the next annual meeting is available. In addition, each participating country is identified with links to related web sites provided. CPP-Phase I strived to continually improve this web site to serve as the main communication tool for this pilot study and this goal will continue in CPP-Phase II.

Despite the success of CPP-Phase I, the leaders of this pilot study want to expand on the level of participation during CPP-Phase II. This report clearly provides the documentation of the value and usefulness of participation in this pilot study. Other countries are urged to participate and attend the next annual meeting to be held in Italy in May of 2003. Countries who are interested in participation should contact:

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